

## **SELF ADJUSTING ELECTRICALLY POWERED PARKING BRAKE ACTUATOR MECHANISM WITH MANUAL RELEASE**

### Cross Reference to Related Application

This application claims the benefit of U.S. provisional Serial No. 60/457,776,  
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## Background of the Invention

This invention concerns electrically powered actuator mechanisms for automobile parking brakes in which an electrical motor is selectively activated to set or release the vehicle brakes by a control switch. Such powered parking brakes add a measure of convenience over the usual manually operated parking brakes.

However, it would be highly desirable that a manual release be incorporated as well as a powered release to allow vehicle operation in the event of failure of the powered system.

Another desirable feature would be a self adjusting mechanism which would automatically take up the brake operating cable slack, which typically will increase over time, to avoid the delay in actuating the brake which would otherwise occur. Such self adjust features have heretofore been incorporated in manually operated parking brakes but have not been incorporated in electrically actuated parking brakes.

Such self adjustment action should desirably eliminate the need for adjustment when the parking brake actuator is installed during vehicle assembly to reduce the labor involved in carrying out the installation.

1               Such a parking brake should itself be compact and reliable while providing these  
2 features.

3               The object of the present invention is to provide an electrically operated actuator  
4 mechanism for vehicle parking brakes which can electrically apply and release the brakes but  
5 which also allows a manual release of the brakes.

6               It is another object of the present invention to provide an electrically powered  
7 actuator mechanism for parking brakes which incorporates a self adjustment of the brake  
8 operator cable to automatically take up any slack which develops to avoid any delay in applying  
9 the parking brake.

#### 10 11 Summary of the Invention

12               These and other objects of the present invention which will be understood upon a  
13 reading of the following specification and claims are achieved by a parking brake actuator  
14 mechanism in which a reversible electrical motor is selectively energized in a first direction to  
15 apply the brakes, and in a second direction to release the brakes.

16               A manual release cable is connected to the parking brake actuation mechanism to  
17 release the brakes when the cable is pulled as by a release lever or button in the passenger  
18 compartment.

19               A prewound clock spring is connected to apply a predetermined tension to the  
20 brake operator cable whenever the brake is released, to take up any slack developing in the  
21 system prior to the next engagement of the brake.

22               A prewound clutch spring establishes a driving connection between a pivot

1 member comprised of a sector gear driven by an electric motor output gearing and a rotary cable  
2 track wind up wheel which is freely rotatable on a drive shaft connected to the sector gear to be  
3 rotated therewith. The cable wind up wheel has an intermediate operator cable partially wrapped  
4 therein in a guide groove in the wind up wheel perimeter which also has a drum clutch surface  
5 over which one section of a the clutch spring is received. An auxiliary drum is drivingly engaged  
6 with the drive pin to be rotated therewith and receives the other section of the clutch spring.

7           When the sector gear is driven by the motor in a direction applying the brakes, the  
8 clutch spring, wrapped tightly onto both drum surfaces, causes the operator cable to be wound up  
9 on the cable operator track up wheel. This pulls the brake cable connected to the brake via a  
10 cable connector and load sensor. When the sensor detects development of a preset cable load,  
11 the motor control circuit turns off the motor. The motor output includes irreversible gearing  
12 which holds the cable in the brake set position.

13           The distribution of the clutch spring engagement stress across both the auxiliary  
14 drum and the cable wind up wheel drum surface reduces the concentration of stress over prior  
15 uses of a clutch spring in manually actuated brakes which concentrated the stress at the first  
16 winding of the clutch spring leading to increased wear.

17           To power release the parking brake, the motor is driven in a reverse direction to  
18 drive the sector gear so as to cause unwinding of the operator cable from the groove on the cable  
19 wind up wheel. The clutch spring at this time continues to maintain a driving connection to the  
20 cable track wind up wheel until a release leg of the clutch spring is driven sufficiently far to  
21 engage a fixed post, causing the clutch spring to be expanded to disengage from both clutch drum  
22 surfaces, releasing the rotary connection between the cable wind up wheel and the sector gear.

1 This allows the torsion developed by the clock spring to act on the released cable wind up wheel  
2 to exert a pull on the brake operator cable and establish a predetermined pretensioning therein  
3 which is not sufficient to operate the brake but sufficient to eliminate any slack. The motor is  
4 then stopped by the control circuit when a rotary position sensor detects sufficient sector gear  
5 travel to insure that release of the clutch spring has occurred.

6 To effect a manual release, a manual release cable wire is pulled by manipulation  
7 of a lever or button in the passenger compartment, which causes rotation of a manual release  
8 lever pivoted on one end of the drive pin. In one embodiment, a separate release cam also  
9 pivoted on the drive pin, engages a first tab on the manual release lever and rotates the release  
10 lever to cause a second tab to be engaged with the release leg of the clutch spring to again release  
11 the cable track wind up wheel. In a second embodiment, the manual release cable wire is directly  
12 attached to the manual release lever.

13 A release lever positioner spring holds that lever in proper position. A release  
14 cam positioner spring on the manual release cable holds the release cam in position retracted  
15 away from the tab on the release lever when the release cam is used.

16 The pretensioning system includes the clock spring which is received within a  
17 cavity within the cable wind up wheel, which has one end connected to the inside of the cable  
18 track wind up wheel cavity and anchored at its other end to the drive pin. The clock spring is  
19 prewound at assembly when the sector gear is driven by the drive motor to release the clutch  
20 spring and allowing free rotation of the cable wind up wheel, the brake operator cable is pulled to  
21 prewind the clock spring to create a stored torsional energy. The operator cable connector is then  
22 held fixedly in that position by insertion of a tension lock pin or clip.

1           After the mechanism is assembled into an automobile, the lock pin or clip is  
2 removed. The prewound clock spring then acts to rotate the cable track wind up wheel to take up  
3 any slack in the brake cable.

4           As soon as the spring clutch is again engaged with the wind up wheel at its new  
5 position, there is no lost motion from cable slack to delay brake engagement.

6           Thus every time the cable track wind up wheel is released, the clock spring  
7 automatically acts to reestablish proper cable tension and repositions the wind up wheel if any  
8 slack develops prior to the next brake application.

9           An alternate sensor installation may provide an indirect measurement of the force  
10 in the brake apply cable by mounting a load sensor to measure the reaction force at the drive pin  
11 generated by the cable tension. This reaction force is used to determine the cable load being  
12 generated by the motor.

#### 13 14 Description of the Drawings

15           Figure 1 is a side view of a parking brake actuator mechanism according to the  
16 present invention.

17           Figure 2 is a top view of the actuator mechanism shown in Figure 1.

18           Figure 3 is an end view of the actuator mechanism shown in Figures 1 and 2.

19           Figure 4 is an exploded pictorial view of a parking brake actuator mechanism  
20 according to the present invention.

21           Figure 5 is a pictorial view of the actuator mechanism with the housing cover  
22 removed to show the interior components of the actuator mechanism at the start of the powered

1 brake apply condition.

2 Figure 6 is a pictorial view of the actuator mechanism components shown in  
3 Figure 5 at the start of the powered brake release operation.

4 Figure 7 is a pictorial view of the actuator mechanism components shown in  
5 Figures 5 and 6 with the manual release of the brakes completed.

6 Figure 8 is a pictorial view of the interior actuator mechanism components viewed  
7 from below to show the self adjust function components.

8 Figure 9 is a pictorial view of actuator mechanism interior components with a  
9 cable wind up wheel, auxiliary drum and clutch spring partially broken away to show the clutch  
10 spring engagement therewith.

11 Figure 10 is a diagram depicting an alternate form of load sensor arrangement  
12 incorporated in the actuator mechanism according to the invention, depicting the force loading.

13 Figure 11 is a side view of an alternate embodiment of the actuator mechanism  
14 according to the invention.

15 Figure 12 is a view of the section 12-12 taken in Figure 11.

16 Figure 13 is an exploded pictorial view of the components of the actuator  
17 mechanism shown in Figures 11 and 12.

18 Figure 14 is a pictorial view from the top of the actuator mechanism shown in  
19 Figures 11 and 12 at the beginning of the brake apply cycle.

20 Figure 15 is a pictorial view from the top of the actuator mechanism shown in  
21 Figures 11 and 12 at the beginning of the powered release cycle.

22 Figure 16 is a pictorial view from the bottom of the actuator mechanism shown in

Figures 11 and 12 prior to operation of the manual release.

Figure 17 is a pictorial view from the bottom of the actuator mechanism shown in Figures 11 and 12 after operation of the manual release.

Figure 18 is a plan view of the cross brace showing one form of the load sensor used to control operation of the motor.

### Detailed Description

In the following detailed description, certain specific terminology will be employed for the sake of clarity and a particular embodiment described in accordance with the requirements of 35 USC 112, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

Referring to Figures 1-3, the electrically powered parking brake actuator mechanism 10 includes a housing 12 adapted to be mounted to a structure within an automotive vehicle by mounting ears 14. The housing 12 is of a two piece construction including an enclosure 16 and a cover 18 with gasket 19 held together with socket head screws 20.

A brake operating cable 22 passes out of the housing 12 and extends to vehicle rear brakes 24, used as parking brakes when operated by the actuator mechanism 10 according to the present invention.

A manual brake release cable 26 also extends out of the housing 12 and extends to a suitable operating lever or button 25 located in the passenger compartment of the vehicle.

Figures 4 and 4a show the components of the actuator mechanism 10 which

1 includes an electric motor-gearing unit 28 which includes an electric motor 30 and a rotary  
2 output comprising a right angle gear unit 32 including an output pinion gear 34 rotated by self  
3 locking worm gearing (not shown) which locks the pinion gear 34 whenever the motor 30 is not  
4 energized. The motor-gearing unit 28 is mounted within the main housing 16.

5           A drive shaft 36 is rotatably mounted in a bearing 38 at one end thereof and  
6 extends through a clock spring 40, an intermediate operator cable wind up wheel 42, and an  
7 auxiliary drum 44. A clutch spring 46 is received over a drum surface 48 on one end of the wind  
8 up wheel 42 and completely over the auxiliary drum 44. Normally the clutch spring 46 tightly  
9 grips both the auxiliary drum 44 and the drum surface 48.

10           The drive shaft 36 also passes through a pivot member, here comprised of a sector  
11 gear 50 having gear teeth 52 formed therein in mesh with the pinion gear 34, a manual release  
12 lever 54, and a locator spring 56. The end of the drive shaft 36 is rotatably mounted in a bearing  
13 58 in a bearing seat 62 formed in a cross brace 60 mounted in the housing 12.

14           A manual release cam 64 has a bore 68 at one corner rotatable on the bearing seat  
15 62 on the opposite side of the cross brace 60, and has a manual release cable 26 attached to one  
16 corner 66 thereof.

17           The drive shaft 36 has a segment 37 formed round but with flats 35 formed on  
18 either side to create a driving relationship with complementary flat sided bore 45 in the auxiliary  
19 drum 44 and flat sided bore 51 in the sector gear 50. The wind up wheel 42 has a round bore 73  
20 allowing free rotation on the drive shaft segment 37. Manual release lever 54 is also rotatable  
21 thereon by receiving the drive shaft segment 37 in a round hole 55.

22           The clock spring 40 is received within a circular cavity 70 inside the cable wind



1 up wheel 42, having an inner formed over end 41 secured to the drive shaft 36 and on outer  
2 formed over end 43 secured to the inside of the cavity 70 (Figures 8, 9). Thus, when the spring  
3 40 is rewound, the cable wind up wheel 42 is urged to rotate so as to partially wind up an  
4 intermediate operator cable 72 having one end held in an anchor 75 by a cross pin 74 and  
5 received in a groove track 76.

6 The other end of the intermediate operator cable 72 is connected to a load sensor  
7 78 and cable coupling 80 to which the brake operating cable 22 is attached.

8 The intermediate operator cable 72 is pulled to rewind the clock spring 40 to be  
9 tensioned to a predetermined level prior to installation of the actuator mechanism 10, and a  
10 temporary locking pin 82 thereafter installed in holes in the housing enclosure 16 (Figure 4) to  
11 maintain the torsional tension in the now wound clock spring 40.

12 Upon installation of the actuator mechanism 10, the locking pin 82 is removed.  
13 The clock spring torsional tension then acts on the cable wind up wheel 42 to pull on the cable 72  
14 and provide the self adjusting feature as described below, since a predetermined cable tension in  
15 the brake operating cable 22 is thereby created.

16 The clutch spring 46 has a tangential drive leg 47 fixed to the sector gear 50 by a  
17 clamping plate 84 attached thereto with screws 86. A release leg 49 is used to expand and  
18 controllably disengage the clutch spring 46 from the drum surface 48 as will be described below.

19 The manual release lever 54 has an elongated finger 53 which extends to be  
20 engagable with the release leg 49 when a tab 65 of the manual release cam 64 engages a tab 57  
21 on the manual release lever upon retraction of the manual release cable 26 as described below.

22 Positioner spring 56 holds the lever 54 away from engagement with the release leg

1 49 until the manual release cable 26 is retracted. A spring 27 on the cable 26 urges the manual  
2 release cam 44 to a disengaged position until the movable core wire in the manual release cable  
3 26 is retracted.

4 Figure 5 shows the sector gear 50 at the beginning of a powered parking brake  
5 application. A control circuit 90 includes a dash mounted switch (not shown) which may be  
6 selectively operated to energize the electric motor 30, causing the sector gear 50 to be pivoted by  
7 rotation of the pinion gear 34 so as to swing the sector gear 50 counter clockwise as viewed in  
8 Figure 5.

9 Since the clutch spring 46 grips the drum surface 48 on the cable wind up wheel  
10 42, the rotation of the attached sector gear 50 rotates the wind up wheel 42 to further wrap up the  
11 intermediate operator cable 72 thereon.

12 This pulls on the brake cable 22 via the connection provided via the load sensor  
13 78 and coupling 80 to apply the brakes 24.

14 The motor 30 continues to operate until a predetermined load is detected by the  
15 load sensor 78, the control circuit 90 then automatically deactivating the motor 30. The brakes  
16 24 remain applied due to the action of the internal self locking gearing included in the motor  
17 drive unit 30.

18 Figure 6 depicts the brake applied position of the sector gear 50.

19 During this operation, the clutch spring 46 grips both the drum surface 48 and the  
20 auxiliary drum 44 so that wear is not concentrated at the first turn on the drum surface 48 but  
21 rather over a wider area.

22 To release the brakes 24, the switch included in control circuit 90 is operated to

1 energize the motor in the reverse direction. The clutch spring 46 continues to grip the drum  
2 surface 48 since it is designed to normally grip the drum surfaces 48, and since the wind up  
3 wheel 42 is continually urged to rotate counter clockwise as viewed in Figures 5 and 6 by the  
4 clock spring 40, so that rotation of the sector gear 50 clockwise causes clockwise rotation of the  
5 wind up wheel 42, releasing tension in the brake cable 22 and thus releasing the brakes 24.

6 The motor 30 continues to operate, carrying the release leg 49 of the clutch spring  
7 46 into engagement with a fixed post 92 as shown in Figure 5.

8 Continued rotation to advance the release leg 49 causes the clutch spring 46 to  
9 expand, releasing its engagement with the drum surface 48.

10 The motor 30 continues to rotate until a position sensor 96 adjacent the sector gear  
11 50 perimeter signals the control circuit 90 that the sector gear 50 has reached a position insuring  
12 full release of the clutch spring 46, the control circuit 90 then causing the motor 30 to be  
13 deactivated.

14 Figure 7 shows a manual release using the manual release cable 26, which has a  
15 core wire pulled by manipulation of a lever or button 25 accessible from the passenger  
16 compartment. The release cam 64 is thereby rotated counter clockwise as seen in Figure 7 about  
17 its axis of rotation defined by the center of bore 68 (bracket 60 and bearing seat 62 not shown for  
18 clarity). The tab 65 engages the tab 57 of the release lever 54, causing rotation thereof in the  
19 same direction. This causes the finger 53 to engage the release leg 49 of the clutch spring 42 and  
20 expand the clutch spring 42 releasing its engagement with the drum surface 48 of the wind up  
21 wheel 42. This releases the intermediate operator cable 72 to thereby relax brake cable 22 and  
22 allow disengagement of the parking brakes 24.

1           The clock spring 40 however continues to act on the wind up wheel 42 so as to  
2 maintain a minimum tension on the intermediate cable 72 to eliminate any slack that has  
3 developed.

4           Upon the next engagement of the clutch spring 46, if any rotation of the wind up  
5 wheel 42 has occurred to eliminate slack, the clutch spring 46 will engage the drum surface 48 in  
6 the rotated position so that only the same travel is necessary to set the brakes, avoiding any  
7 cumulative slow down of the actuation time necessary.

8           Figure 10 depicts an alternate form of load sensor, in which a pivot 98 on the end  
9 of the drive shaft 36 is held by a slide 100 mounted on the bracket 60A. A load sensor 102  
10 senses the reaction load on the pivot 98. The pivot 98 is subjected to part of the reaction force  
11 generated by the tension in the cable 22, and hence the load sensor 102 can be used to detect the  
12 level of force causing the motor 30 to be deactivated, since it corresponds to the force applied to  
13 the brakes 24.

14           The components can be arranged differently, as for example in a second  
15 embodiment of an actuation mechanism 10A shown in Figures 11-17. In this embodiment, the  
16 electric drive motor 30A has its axis oriented parallel to the axis of the cable wind up wheel 42A  
17 and pivot member comprised of sector gear 50A.

18           The motor 30A is received in a recess 104 in the housing enclosure 16A secured  
19 with screws 106 passing through tabs 108 and received in sockets 110 and has an output gear unit  
20 including a pinion gear 34A meshed with gear teeth 52A on the sector gear 50A.

21           A drive shaft 36A has a pin 112 on one end received in a bearing sleeve 38A in  
22 turn held in socket 114 molded in the rear wall of the housing enclosure 16A.

1           The pinion gear 34A also has a plug end 116 received in a mating hole 111 in a  
2 cross brace 60A having three ends 118A, B, C, received in corresponding recesses 120A, B, C  
3 and molded into the housing 16A and secured with screws (not shown).

4           The drive shaft 36A has a reduced diameter end 122 received in a bearing 124  
5 received in a bearing socket 62A formed in the brace 60A.

6           The drive shaft 36A has flats 126 on a rounded portion 37A mating with  
7 elongated opening 51A in the sector gear 50A and opening 45A in the auxiliary drum 44A so as  
8 to rotate together.

9           The drive shaft 36A provides rotary support for the cable wind up wheel 42A.  
10 The manual operating lever 54A is rotatably mounted on an outside diameter 128 of the socket  
11 114 received in a large diameter hole 55A therein.

12           In this second embodiment, the manual release lever 54A is itself directly  
13 connected to the manual release cable 26 by a cross pin 136 on the core wire 135 interfit in a  
14 looped end of an arm 131 of a wound wire spring 130, the wire spring 130 having the formed  
15 arm 131 received in notch 132 in the manual release lever 54A, with the opposite arm 133  
16 anchored against the housing enclosure 16A, as best seen in Figures 16 and 17.

17           The clock spring 40A has its inner formed over end 41A received in a slot 35 in  
18 the drive shaft 36A and its outer formed over end 43A held in a cylindrical cavity 41 in the cable  
19 wind up wheel 42A.

20           The clutch spring 46 is received over a drum surface 48A of the cable wind up  
21 wheel 42A and also the auxiliary drum 44A, as in the first described embodiment.

22           A spring clip 138 is used to hold the operator cable 72 with the clock spring 40A

1 in the prewound condition until the actuator 10A is installed in the vehicle, one edge engaging  
2 connector 140.

3 A load sensor 142 is engaged by a slider 138 abutting the plug end 122 of the  
4 drive shaft 36A (Figure 14) to provide a control signal corresponding to the cable load on the  
5 brake cable 22.

6 The actuator 10A generally operates in the same manner as the first described  
7 embodiment.

8 The motor 30A when energized drives the sector gear 50A, which in turn rotates  
9 the cable wind up wheel 42A by the driving connection created by the spring clutch 46A. This  
10 continues until the load sensor 142 senses a tension load sufficient to set the brakes (Figure 14)  
11 and the control circuit (not shown) turns off the motor 30A. The brakes 24 are held in the  
12 applied condition by the self locking motor gearing.

13 To power release, the motor 30A is activated to drive in the opposite direction to  
14 rotate the sector gear 50A in the opposite direction unwinding the cable 72 until the leg 49A  
15 engages post 92A to expand and release the clutch spring 46A (Figure 15). The motor 30A is  
16 turned off when a sector gear position sensor (not shown) senses that sufficient travel has  
17 occurred to insure release of the clutch spring 46A and then de-energize the motor 30A as in the  
18 first described embodiment.

19 Referring to Figures 16 and 17, the manual release lever 54A is rotated when the  
20 core wire 135 of the manual release cable 26 is drawn back, causing a tab 53A to engage release  
21 arm 49A of the clutch spring 46A and disengage the clutch spring 46A.

22 Figure 18 shows the bracket 60A which is formed with the seat 62A receiving a

1 bearing 124 supporting the reduced diameter end 122 of the drive shaft 36A (Figure 12). An  
2 alternate form of load sensor takes advantage of the fact that the leg 144 of the bracket 60A is  
3 placed in compression by the reaction of drive shaft 36A to the load of the brake cable 22. A  
4 strain gauge 146 is used to measure the level of that compression to provide the load signal for  
5 turning off the motor 30A at the proper time during the brake apply cycle.

6